REMARKS

In the Office Action, the Examiner requests an affirmation of a provisional election made during a telephone conversation with Phillip Lee (Reg. No. 48,866), objects to the drawings, and rejects claims 1-19 under 35 U.S.C. §103(a) as being unpatentable over Kawakami et al. (U.S. Patent No. 5,847,326) and further in view or Tanifuji et al. (U.S. Patent No. 5,627,344). The rejections are fully traversed below. Reconsideration of the application is respectfully requested based on the following remarks.

Claim 8 has been amended to further clarify the subject matter regarded as the invention. Claims 25-27 have been added. Claims 13 and 20-24 have been canceled. Accordingly, claims 1-12, 14-19 and 25-27 are now pending in this application.

ELECTION OF INVENTIONS

Applicant hereby confirms the election of Group I, claims 1-19, made during a telephone conversation with the Examiner on April 12, 2002.

OBJECTIONS TO THE DRAWINGS

Proposed changes to the Figures include adding FIG. 5 and changing FIGS. 1, 2A, 2B, and 3 as indicated in red in the substitute sheets of drawings. FIG. 5 has been added to include more clearly that the ring 214 of dielectric material is partially embedded within the surface of the first ceramic layer as claimed in claims 4 and 17. FIG. 5 also includes a printed circuit board 218 for which a ceramic circuit structure is mounted onto as claimed in claims 5, 12, and 18. In addition, FIG. 1, 2A, 2B, and 3 have been changed to include cross hatching patterns consistent with those shown on pages 600-95 and 600-96 of the MPEP, Eighth Edition. The cross hatching patterns are chosen based on the material of the part that is described in the specification at page 5 lines 33-34; page 6 lines 11-13; page 6 line 29; page 6 line33 – page 7 line 2; and elsewhere, and thus introduces no new matter. Likewise, FIG. 5 includes such cross hatching patterns.

REJECTION OF CLAIMS UNDER 35 U.S.C. § 103

Claims 1 and 15 relate to a ceramic circuit structure that requires among other things a dielectric ring. Specifically, the dielectric ring covers "a peripheral portion of the contact pad and an adjacent portion of the dielectric material layer surface immediately surrounding the contact pad". Dielectric rings are described throughout the specification and the drawings; for example, they are indicated with reference number 214 in FIG. 2A and 2B. Dielectric rings in the manner claimed are efficient and cost effective structures for providing structural integrity to a Low Temperature Co-fire Ceramic System (LTCC) module after the module has been attached to a printed circuit board in that the thermal cycle fatigue life is increased. In some cases the fatigue life is increased at least five fold over LTCC modules that lack structures such as the dielectric ring.

In rejecting claims 1 and 15, the Examiner took Official Notice that "coating of solder mask or resist is *known* in the art for protecting the outer surface for environmental degradation", facts which are outside of the record. The Applicant respectfully traverses all assertions of Official Notice and requests that the Examiner cite references, which would support the assertions of Official Notice. Although the Examiner states that Kawakami et al. discloses an overcoat glass layer 22, Kawakami et al. neither teaches nor suggests "a dielectric **ring**" much less "a dielectric ring covering a **peripheral portion of the contact pad** and an **adjacent portion of the dielectric material layer surface immediately surrounding the contact pad**". Instead, Kawakami et al. just discloses an overcoat glass layer with an amorphous shape generally formed over electrical components (e.g., resistor 21) in their entirety. Similarly, Tanifuji et al. merely discloses an intermediate metal layer within a multi-layer ceramic circuit substrate. It is submitted that Kawakami et al. and Tanifuji et al., alone or in any combination, do not teach or suggest the features of the claimed invention. Therefore, it is submitted that claims 1 and 15 are patentably distinct from the cited references.

Amended independent claim 8 also relate to a ceramic circuit structure that requires among other things "a contact pad **embedded** within a surface of the first ceramic layer such that a surface of the contact pad is **flush** with the surface of the first ceramic layer", a limitation set forth in now canceled claim 13. However, in rejecting claim 13 in the Office Action, the Examiner took Official Notice that "such design is *known* in the art to just expose the pad for connection and not the conductor pattern to have better control of the short circuit without even additional mask or resist", facts which are again outside of the record. The Applicant respectfully traverses all assertions of Official Notice and requests that the Examiner cite

references, which would support the assertions of Official Notice. Further, claim 8 as amended requires that "a barrier cap formed in contact with and between the catch pad and the contact pad such that the barrier cap is **encapsulated within** the first ceramic layer". (Support for the amendments may be found on FIG. 2A) It is submitted that Kawakami et al. and Tanifuji et al., alone or in any combination, do not teach or suggest the features of the claimed invention. Therefore, it is submitted that claim 8 is patentably distinct from the cited references.

The Examiner's rejections of the dependent claims are respectfully traversed. However, to expedite prosecution, all of these claims will not be argued separately. Claims 2-7, 9-12, 14, and 16-19 each depend either directly or indirectly from independent claims 1, 8, or 15 and, therefore, are respectfully submitted to be patentable over cited art for at least the reasons set forth above with respect to claims 1, 8, or 15. Further, the dependent claims require additional elements that when considered in context of the claimed inventions further patentably distinguish the invention from the cited art.

SUMMARY

It is respectfully submitted that all pending claims are allowable and that this case is now in condition for allowance. Should the Examiner believe that a telephone conference would expedite the prosecution of this application, the undersigned can be reached at the telephone number set out below.

If any fees are due in connection with the filing of this Amendment, the Commissioner is authorized to deduct such fees from the undersigned's Deposit Account No. 50-0388 (Order No. **NSP1P202**).

Respectfully submitted,
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VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION

(Paragraph on page 5, line 14 - page 6, line 5):

FIG. 2A is now presented to diagrammatically illustrate the structure of one possible embodiment of the present invention. FIG. 2A is a side plan, cross-sectional view of a portion of the bottom ceramic layer 202 of a multi-layered LTCC module 200. To provide an additional perspective view of the structure, FIG. 2B illustrates a top plan view of the bottom surface 212 of layer 202. As can be seen in FIG. 2A, a conductive trace 204, which is on the upper surface 201 of layer 202, is electrically connected to electrically conductive material within through-hole 206. Through-hole 206 is a passageway that passes through a substantial portion of the layer's thickness. The electrically conductive material within the through-hole 206 forms via 207. At the end of via 207, opposite conductive trace 204, is formed a catch pad 208. A conductive barrier cap 209 is formed in connection to catch pad 208. Barrier cap 209 forms an intermediate conductive material through which catch pad 209 is connected to the material forming contact (or solder) pad 210, which is formed on the bottom surface 212 of layer 202. Barrier cap 209 serves as a barrier that prevents chemical reactions from occurring between the material of via 207 and catch pad 208 with the material of contact pad 210. Layer 202 is typically the bottom layer of a laminate LTCC module. A ring of dielectric material 214 is formed on the bottom surface 212 of layer 202 such that the perimeter of the contact pad 210 and the portion of the ceramic layer 202 immediately surrounding the contact pad 210 is covered by the ring. Within the ring 214 and on the surface of the contact pad 210 is placed solder material 216. Solder 216 is used to attach the LTCC module 200 to an electronic substrate, such as a printed circuit board **218 (see FIG. 5)**. It is common to use a lead/tin composite material for the solder material 216. Again, FIG. 2B illustrates a plan view of the bottom surface 212 of layer 202 to provide a greater appreciation for the structural design of the specific embodiment of the present invention. In FIG. 2B, it can be seen that the perimeter of the ring 214 extends beyond the outer surface of the solder material 216. It is, however, not necessary that the outer perimeter of the dielectric ring 214 extend beyond the outer surface of the solder material 216.

(Paragraph on page 6, line 6 - page 6, line 13):

Ring 214 is formed of a dielectric material and functions to prevent solder material 216 from making contact with the perimeter of contact pad 210 and the portion of the ceramic material immediately surrounding contact pad 210. **Ring 214 may either be formed on top (See FIG. 2A) or be partially embedded within (See FIG. 5) surface 212.** Ring 214 increases the structural integrity to the LTCC module after the module has been attached to a printed circuit board in that the thermal cycle fatigue life is increased. In some cases the fatigue life is increased at least five fold over LTCC modules which lack structures such as rings 214. In this embodiment, ring 214 is formed of a glass dielectric ink. Dupont glass dielectric ink #5682, as well as other suitable materials, may be used.

IN THE CLAIMS

8. (Once Amended) A ceramic circuit structure having a plurality of ceramic layers and at least one electronic component embedded within the plurality of ceramic layers, wherein a first one of the ceramic layers comprises:

a through-hole that passes through the first ceramic layer, the through-hole being filled with a first electrically conductive material, which forms a via;

a catch pad formed at one end of the via;

a contact pad **embedded within[formed on]** a surface of the first ceramic layer **such that a surface of the contact pad is flush with the surface of the first ceramic layer**, the contact pad formed from a second electrically conductive material that is different from the first electrically conductive material; and

a barrier cap formed in contact with and between the catch pad and the contact pad **such that the barrier cap is encapsulated within the first ceramic layer**, the barrier cap being formed from a third electrically conductive material that is different from the first and second electrically conductive materials.

APPENDIX: CURRENTLY PENDING CLAIMS

1. A ceramic circuit structure having a plurality of ceramic layers and at least one electronic component embedded within the plurality of ceramic layers, wherein a first one of the ceramic layers comprises:

a through-hole that passes through the first ceramic layer, the through-hole being filled with a first electrically conductive material, which forms a via;

a contact pad formed on a surface of the first ceramic layer, the contact pad formed from a second electrically conductive material that is different from the first electrically conductive material;

a barrier cap formed in contact with and between the via and the contact pad, the barrier cap being formed from a third electrically conductive material that is different from the first and second electrically conductive materials; and

a dielectric ring covering a peripheral portion of the contact pad and an adjacent portion of the dielectric material layer surface immediately surrounding the contact pad, such that any solder that is applied to the contact does not contact the peripheral portion of the contact pad or the ceramic material.

2. A ceramic circuit structure as recited in claim 1 wherein the barrier cap prevents the first electrically conductive material within the through-hole from making contact with the second electrically conductive material forming the contact pad.

3. A ceramic circuit structure as recited in claim 1 wherein the ring of dielectric material is formed of glass.

4. A ceramic circuit structure as recited in claim 1 wherein the ring of dielectric material is partially embedded within the surface of the first ceramic layer.

5. A ceramic circuit structure as recited in claim 1 wherein the ceramic circuit structure is mounted onto a printed circuit board, and wherein the first ceramic layer of the plurality of ceramic layers is directly adjacent to the printed circuit board.

6. A ceramic circuit structure as recited in claim 1 wherein the contact pad is embedded within the surface of the first ceramic layer such that a surface of the contact pad is flush with the surface of the first ceramic layer.

7. A ceramic circuit structure as recited in claim 1 wherein the first electrically conductive material filling the through-hole is palladium-silver, the second electrically conductive material forming the contact pad is platinum-gold, and the third electrically conductive material forming the barrier cap is gold.

8. (Once Amended) A ceramic circuit structure having a plurality of ceramic layers and at least one electronic component embedded within the plurality of ceramic layers, wherein a first one of the ceramic layers comprises:

a through-hole that passes through the first ceramic layer, the through-hole being filled with a first electrically conductive material, which forms a via;

a catch pad formed at one end of the via;

a contact pad embedded within a surface of the first ceramic layer such that a surface of the contact pad is flush with the surface of the first ceramic layer, the contact pad formed from a second electrically conductive material that is different from the first electrically conductive material; and

a barrier cap formed in contact with and between the catch pad and the contact pad such that the barrier cap is encapsulated within the first ceramic layer, the barrier cap being formed from a third electrically conductive material that is different from the first and second electrically conductive materials.

9. A ceramic circuit structure having as recited in claim 8 further comprising:

a dielectric ring covering a peripheral portion of the contact pad and an adjacent portion of the dielectric material layer surface immediately surrounding the contact pad, such that any solder that is applied to the contact does not contact the peripheral portion of the contact pad or the ceramic material.

10. A ceramic circuit structure as recited in claim 8 wherein the barrier cap prevents the first electrically conductive material within the through-hole from chemically reacting with the second electrically conductive material forming the contact pad.

11. A ceramic circuit structure as recited in claim 9 wherein the ring of dielectric material is formed of glass.

12. A ceramic circuit structure as recited in claim 8 wherein the ceramic circuit structure is mounted onto a printed circuit board, and wherein the first ceramic layer of the plurality of ceramic layers is directly adjacent to the printed circuit board.

14. A ceramic circuit structure as recited in claim 8 wherein the first electrically conductive material filling the through-hole is palladium-silver, the second electrically conductive material forming the contact pad is platinum-gold, and the third electrically conductive material forming the barrier cap is gold.

15. A ceramic circuit structure having a plurality of ceramic layers and at least one electronic component embedded within the plurality of ceramic layers, wherein a first one of the ceramic layers comprises:

a through-hole that passes through the first ceramic layer, the through-hole being filled with a first electrically conductive material, which forms a via;

a contact pad formed on a surface of the first ceramic layer, the contact pad formed from a second electrically conductive material that is different from the first electrically conductive material; and

a dielectric ring covering a peripheral portion of the contact pad and an adjacent portion of the dielectric material layer surface immediately surrounding the contact pad, such that any solder that is applied to the contact does not contact the peripheral portion of the contact pad or the ceramic material.

16. A ceramic circuit structure as recited in claim 15 wherein the ring of dielectric material is formed of glass.

17. A ceramic circuit structure as recited in claim 15 wherein the ring of dielectric material is partially embedded within the surface of the first ceramic layer.

18. A ceramic circuit structure as recited in claim 15 wherein the ceramic circuit structure is mounted onto a printed circuit board, and wherein the first ceramic layer of the plurality of ceramic layers is directly adjacent to the printed circuit board.

19. A ceramic circuit structure as recited in claim 15 wherein the contact pad is embedded within the surface of the first ceramic layer such that a surface of the contact pad is flush with the surface of the first ceramic layer.

25. (New) A ceramic circuit structure as recited in claim 1, further comprising:

a solder ball formed within the dielectric ring.

26. (New) A ceramic circuit structure as recited in claim 8, further comprising:

a solder ball formed within the dielectric ring.

27. (New) A ceramic circuit structure as recited in claim 15, further comprising:

a solder ball formed within the dielectric ring.